A PRELIMINARY INVESTIGATION OF GROUND WATER CHEMISTRY IN THE KINGS MOUNTAIN-CHARLOTTE AREA

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INSTITUTE OF GOVERNMENT
THE UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL

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A final report in this series is also planned for publication during 1966, and possibly one other Paper.

FOREWORD

Use of the ground for water supply and for waste disposal or certain other purposes represents a dichotomy that focuses attention on ground water contamination or on water of inferior quality in the ground, whatever the cause. Interspersed with water wells and springs in the United States are several millions of septic tanks and many other thousands of sites where a great variety of wastes are disposed of at the ground surface or slightly below it. The general outlines of the problem of ground water contamination have been delineated by Harry LeGrand who says that water associated with these waste sites

> become a part of the subsurface water system, and their soluble constituents move toward points of ground water discharge in stream valleys or water wells. In the majority of instances the concentration of contaminants is reduced to harmless levels before wells are reached.
>
> Yet in an alarming number of places, contamination of ground water is a serious problem. As contaminated ground water spreads, it denies to man's use the storage space formerly occupied by uncontaminated water. Thus, the volume of potable water in underground storage is shrinking while the need for water increases. Other serious aspects of contamination are the danger it poses to health and the high costs of its elimination or prevention.*

The need for a public readiness to meet evolving problems of ground water contamination is being dramatized today for North Carolinians in a classic clash of developmental and conservation interests in Southeastern North Carolina. A major phosphate mining and processing plant is rising in coastal Beaufort County, with good prospects for one or more additional projects of similar magnitude. Its coming has ushered in a complex of water resource problems, involving quality and quantity aspects of both surface and ground waters. Installation of this initial plant, owned by the Texas Gulf Sulphur Company, has initiated daily ground water pumpage of approximately 60 mgd, which is required in order to reduce artesian pressure in the underlying aquifer to facilitate the mining

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*Harry E. LeGrand, "System for Evaluation of Contamination Potential of Some Waste Disposal Sites." Journal American Water Works Association, Vol. 56, No. 8, August 1964. (Copyright 1964, Journal American Water Works Association.)

operations, and also serves as a source to meet the plant's heavy process water needs. Such gross water movements are not without adverse side effects, as illustrated in this case by reduced ground water pressures in neighboring wells and a potential long-term risk of salt water intrusion and contamination of a rich ground water aquifer.

North Carolina today is ill prepared to muster a constructive response to the ground water quality problems incidental to this major mining operation, or to other such problems of lesser magnitude.

The present capacity for collective action in this State to cope with or ward off occurrences of ground water contamination is quite limited. Little technical literature is available on the subject. Economic aspects have not been explored. Rules of law governing disputes among the polluters and the polluted are in a primitive stage, as is the development of governmental machinery to grapple with the issues. Under the stimulus of the Texas Gulf Sulphur development, a crash effort is now under way in the North Carolina Department of Water Resources to explore the need for new legislation to control ground water use. Whatever the outcome of this immediate effort, however, underlying deficiencies in basic research and information will remain.

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This paper was conceived originally--at the suggestion of Harry LeGrand, USGS ground water hydrologist--as a vehicle for exploring typical patterns of ground water contamination in North Carolina, to be correlated with existing rules of law governing ground water disputes. Discussions with LeGrand and Professor Paul Ragland of the U.N.C. Department of Geology led to the more modest objectives that were ultimately set: to establish background information regarding the chemical character of ground water in a typical Piedmont area, using the Department's facilities for atomic absorption spectrophotometry. Background studies of this nature are needed as a monitor of water quality conditions, and may also be helpful in establishing indices of the presence or movement of contaminants in the ground. It is hoped that this publication will stimulate further studies that are an essential foundation to adequate programs of ground water quality management.

Field work and laboratory analysis for this study was performed by Van Price, a graduate student in the Department of Geology of the University

of North Carolina at Chapel Hill, under the supervision of Professor Paul Ragland. Harry LeGrand lent valued help in defining the project and in editorial review of the paper.*

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This paper is one of a number of monographs in a series devoted to the investigation and evaluation of water use arrangements in North Carolina. The over-all research program has been supervised by the Institute of Government and supported by a grant from the U. S. Public Health Service. Publication of the last of the individual monographs in this series, and of a final report, will be completed later this year.

Milton S. Heath, Jr.
Institute of Government
Chapel Hill - May 1966

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*This paper embodies an abbreviated version of the findings made by Price and Ragland. A full report was presented at the annual meeting of the Southeastern Section of the Geological Society of America (April 1966, Athens, Georgia). The full report will be submitted to Economic Geology for possible future publication.

INTRODUCTION

During the summer of 1965, selected samples of ground water and surface water were collected in parts of Cleveland, Gaston, and Mecklenburg Counties, North Carolina, and these samples were analyzed for certain chemical constituents. The purpose of the project was to establish background information on the presence of certain metal ions in ground water. The region was selected because it is underlain by igneous and metamorphic rocks, typical of those in the Piedmont and Blue Ridge Provinces of the Southeastern States. In addition to the occurrence of typical rocks, the region has mineral deposits that may contain water of anomalous character. In establishing the distribution of chemical constituents in the water, it was thought that the results might throw light on specific health problems relating to the mineral constituents naturally occurring and to aspects of contamination of underground water. Another consideration was the degree to which the chemical character of the water might correlate with types of rocks and with certain mineral deposits.

It has been known for many years that certain chemical constituents in water are beneficial and that others are harmful. It has long been established that significant amounts of fluoride in ground water has inhibited decay of children's teeth. On the other hand, excessive amounts of sodium in the water may tend to be harmful to some persons with heart trouble. The relation of certain chemical constituents in the water with congenital malformations has been suggested but has not been clearly established. The possibility that some chemical constituents analyzed might be a precursor or forewarner of contaminated underground water was also considered as an objective. In view of the fact that the project was of a reconnaissance nature, no health problems were studied specifically, and no attempt was made to correlate certain constituents in the water with local health conditions. Such plans should be pursued only after a background of chemical character of the water is established and only if certain natural anomalies are suspected or are indicated.

Consideration was given to correlating the type of rock with the chemical character of the water. If such correlation could be established easily, geologic mapping might be greatly facilitated; present mapping

conditions are difficult because of the thick soil cover in the southern states which tends to conceal the true character of the underlying rocks.

ANALYSES AND INTERPRETATIONS

The water samples were analyzed in the geochemical laboratory of the University of North Carolina at Chapel Hill. Analyses were determined for lithium (Li), sodium (Na), potassium (K), rubidium (Rb), magnesium (Mg), calcium (Ca), strontium (Sr), copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn), by atomic absorption spectrophotometry. This method was chosen because it is rapid and precise and because it is sensitive in many cases to a few parts per billion.

A detailed report showing individual analyses and locations of water samples will be released in a geological publication in the future. The average composition of ground water from the various rock types is shown in table 1. Lithium and rubidium were detected in only a few samples, and these are not shown in table 1. The five samples in which lithium was detected lie roughly within the Kings Mountain lithium-producing belt. Iron and manganese values are relatively low, probably because of precipitation of their hydroxides after collection. Contours of the zinc concentration approximately coincide with the zone of sulfide mineralization. The ground waters relatively high in calcium content were found to correlate with the Gaffney Marble, and several samples with high calcium content were thought to represent lenses or inclusions of marble in schists of the region.

High sodium content in two cases was thought to be due to contamination of the ground water. A sample of water from a well at Grover, North Carolina, yielded 96 mg/l Na; this represented contamination from rock salt which was dumped by the local mill on the ground a few tens of feet from the well. This sample was one of the few with detectable concentrations of rubidium. A sample from central Cleveland County yielded 40 mg/l Na which is thought to have represented contamination from a large barnyard. Table 2 shows a summary of stream samples most of which were taken from southern Mecklenburg County; these samples generally represent water that was contaminated, to some degree, by flowing through urban areas. For example, sample 3 containing 110 mg/l Na was collected from Sugar Creek at Pineville, a stream which flows through downtown Charlotte.

TABLE 1*

Average Composition of
Groundwater from Various Rock Types

	granites and schists (1)	mafic rocks (2)	marble (3)	quartzite (4)
Na	4.93	11	6.3	1.8
K	1.19	1.9	2.3	.08
Ca	2.55	7.8	20	0.5
Mg	1.78	14	4.4	0.7
Zn	0.9 (5)	0.9	1.0	0.4
Sr (6)	.03	.04	.07	

*All values in mg/l (=ppm)

(1) 40 samples
(2) 3 samples
(3) 4 samples
(4) 2 samples
(5) 49 samples
(6) average of 12 samples which contained detectable Sr

TABLE 2*

Composition of Six Stream Samples from Mecklenburg County

Sample No.	Na	K	Ca	Mg	Zn	Cu	Sr	Fe	Mn
1	11	1.9	3.5	2.7			.03	.30	.18
2	9.0	1.8	3.7	3.3			.04	.40	.13
3	110	10	8.0	4.2			.04		.34
4	13	3.5	12	11			.12		.10
5	11	2.2	6.7	5.5			.04		
6	10	2.3	6.4	5.7			.05		.07

*All values in mg/l

CONCLUSIONS

The general distribution of certain metal ions in water in the igneous and metamorphic rocks of a part of the Southeastern States was established in the present study. In a general sense, the chemical types of rocks can be delineated by water chemistry. For example, the mafic rocks--those rich in calcium and magnesium silicates--tend to show higher calcium and magnesium dissolved in the water than do the granites and the light colored schists. A marble belt extending northeastward and southwestward from Kings Mountain can also be delineated by the relatively high calcium content in water which circulates in it. A belt of lithium-rich rocks also extending northeastward and southwestward near Kings Mountain tends to have water that is slightly higher in lithium content than that of any other rock. The mineralized sulfide zones in the region tend to have higher zinc concentrations in water than other rocks. More extensive sampling and analyses of other chemical constituents probably would be even more helpful in geologic mapping of the region. In addition to normal geologic mapping, the analyses of water offer a geochemical tool in certain mineral prospecting within the region.

In a general way the mineral constituents analyzed do not appear to occur in harmful concentrations in the region, although human tolerances, as well as beneficial aspects, of certain constituents have not been clearly established. The relatively high sodium content of several waters that appear to be associated with contaminated waters suggest that sodium might be a useful index in determining the movement of contaminated water in the ground. Both the natural health aspects as well as the possibility of using a chemical constituent as a precursor of contamination deserve further consideration.